Fabrication Process and Electronics Development for Scaling Segmented MEMS DMs, Phase I

Completed Technology Project (2013 - 2013)

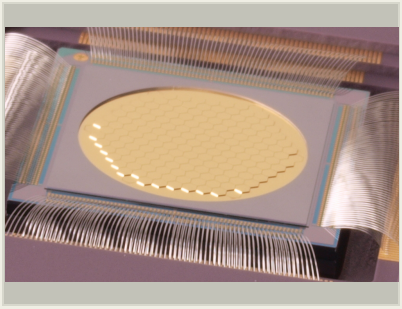
Project Introduction

Microelectromechanical systems (MEMS) technology has the potential to create deformable mirrors (DM) with more than 10^4 actuators that have size, weight, and power specifications that are far lower than conventional piezoelectric and electrostrictive DMs. However, considerable development is necessary to take state-of-the-art DMs today and make them flight-like. This Phase I SBIR proposal addresses two critical areas in MEMS DM development towards the goal of developing flight-like hardware. Namely, Phase I research will further develop Iris AO's proven hybrid MEMS DM technology to: 1) make a critical assembly step in the fabrication process scalable to wafer scales and 2) increase drive electronics resolution to 16 bits while simultaneously reducing power requirements more than three-fold over existing 14-bit resolution electronics. The increased spatial and actuator resolution afforded by the development here will enable picometer resolution DMs required to reach 10^10 contrast levels necessary for direct detection of Earth-sized terrestrial planets.

Anticipated Benefits

Iris AO technology can be a key enabling component in a host of future NASA missions, including the space telescopes of the 'Origins' program including Terrestrial Planet Finder (TPF), Space Astronomy Far Infrared Telescope (SAFIR), Life Finder, and Planet Imager. Four recent ASMCS concepts require multiple DMs to implement coronagraphs. Two of these, DAViNCI and EPIC, specifically require segmented MEMS DMs. Other potential programs such as Structure and Evolution of the Universe (SEU) and ultraviolet telescopes will also require adaptive optics. Finally, ground based telescopes, like the Thirty Meter Telescope (TMT), Keck, and Gemini North & South, require adaptive optics to remove aberrations caused by atmospheric turbulence. Another potential area for Iris AO technology is in laser communications with satellites. Iris AO DMs are capable of handling tens to hundreds of Watts of optical power with dielectric coatings. The DMs could be used to compensate for atmospheric turbulence that inhibits downlink and uplink bandwidth.

The proposed adaptive optics technology would find immediate application in several military communications and imaging products. Systems used in military surveillance such as in the Predator drone and Global Hawk would benefit from the high-resolution, light weight, and low power consumption afforded by Iris AO's MEMS. Amtospheric correction enabled by these low-cost but highly capable devices would benefit space situational awareness surveilance applications as well. In the commercial sector, adaptive optics has been employed in research systems in biological imaging, most notably in vision science and microscopy. Several research universities are reporting results using AO-equipped systems. The high segment-count devices enabled



Fabrication Process and Electronics Development for Scaling Segmented MEMS DMs, Phase I Briefing Chart Image

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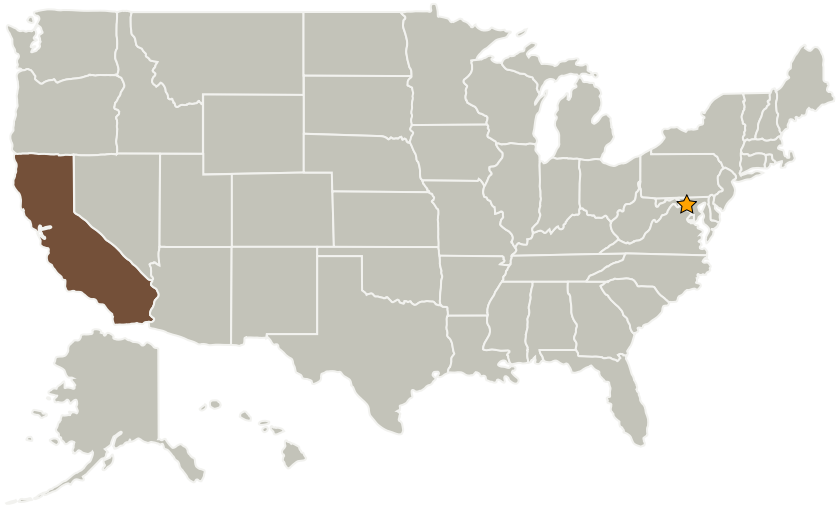
by this proposal would lead to unprecedented levels of spatial fidelity for biological imaging applications. Other commercial applications include metrology, laser processing, coherent combination of multiple fiber lasers, and laser beam quality improvement and drift compensation. Iris AO segmented mirrors are uniquely well-suited to higher power applications such as laser processing, combining fiber lasers, and laser beam quality improvement. This advantage lies in the relatively thick segments that enable the use of dielectric coatings which tend to warp conventional surface micromachined MEMS DMs. The precision open-loop operation of Iris AO DMs greatly simplifies the use of DMs in these applications.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

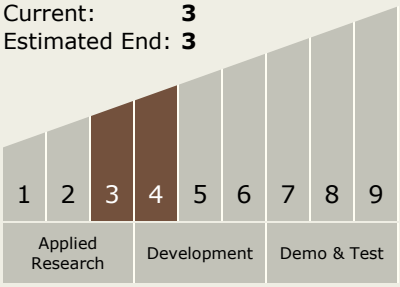
Carlos Torrez

Principal Investigator:

Michael A Helmbrecht

Technology Maturity (TRL)

Start: **4**
Current: **3**
Estimated End: **3**



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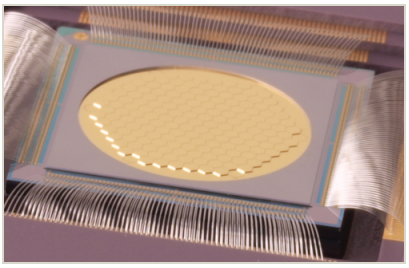
Images



Briefing Chart Image
Fabrication Process and Electronics Development for Scaling Segmented MEMS DMs, Phase I Briefing Chart Image
(https://techport.nasa.gov/image/30396)

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.2 Thermal Control Components and Systems
    - TX14.2.8 Measurement and Control